REAL MONEY BALANCES IN PRODUCTION FUNCTION: A TRANSLOG PROFIT FUNCTION APPROACH

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A THESIS
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By

Mahmut İlerisoy
September 1998

I certify that I have read this thesis and that in my opinion it is fully adequate,in scope and in quality, as a thesis for the degree of Master of Arts in Economics.

Assoc. Prof. Dr. Syed Fakhre Mahmud (Supervisor)

I certify that I have read this thesis and that in my opinion it is fully adequate,in scope and in quality, as a thesis for the degree of Master of Arts in Economics.

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I certify that I have read this thesis and that in my opinion it is fully adequate,in scope and in quality, as a thesis for the degree of Master of Arts in Economics.

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ABSTRACT

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Mahmut İlerisoy

M.A. in Economics

Supervisor: Assoc. Prof. Dr. Syed Fakhre Mahmud

September 1998

This thesis examines the role of real money balances in production function as a factor. A transcendental logarithmic (translog) profit function is estimated with share equations for disaggregated 2 digit Canadian manufacturing industries which are clothing, food, furniture, and wood industries using Zellner's seemingly unrelated algorithm in the TSP computer programme. Both long-run and short-run profit maximizing elasticities are computed. Based upon the results of price elasticities, we have evidence for a significant role of real money balances in production function as a factor both in long-run and short-run. Another interesting result that emerges from our study is the significance of the potential supply side effects of changes in the interest rate on both labor demand and supply of output.

Keywords: Real money balances, production function, translog profit function, Canadian Manufacturing Sector.

ÖZET

TRANSLOG KAR FONKSİYONU YAKLAŞIMIYLA PARA ARZININ ÜRETİM FONKSİYONUNA KATKISININ İNCELENMESİ

Mahmut İlerisoy
İktisat Bölümü, Yüksek Lisans
Tez Yöneticisi: Doç. Dr. Syed Fakhre Mahmud
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Bu çalışma, para arzının üretim fonksiyonunda bir etmen olarak yer alıp almadığını incelemektedir. Bu amaca ulaşmak için tranlog kar fonksiyonu, kar payı denklemleriyle beraber Kanada İmalat Sanayii'ne ait veriler kullanılarak tahmin edilmiştir. Ve uzun ve kısa vade için değişkenler arasındaki elastikiyetler hesaplanmıştır. Alınan sonuçlara göre para arzının üretim fonksiyonuna dahil edilmesi için yeterli delil bulunmuştur. Diğer bir sonuç da faiz oranlarındaki değişimlerin işçi talebi ve üretim üzerindeki etkisinin tesbit edilmesidir.

Anahtar Kelimeler: Para Arzı, üretim fonksiyonu, translog kar fonksiyonu, dualite, Kanada imalat sanayii.

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I am grateful to my family for their support and understanding during my whole life.

To the Memory of

Canan İlerisoy

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CHAPTER 1

INTRODUCTION

Inclusion of real money balances in the production function as a factor input is still being debated in the economic literature. The reason why real money balances is thought to be included in the production function is related to the increased economic efficiency of a monetary economy compared to that of a barter economy. The standard neoclassical production function uses real output and real inputs. However, in order to obtain inputs, to organize and eventually use them in production, it is necessary to engage in exchange. Fortunately with money used as a medium of exchange, unlike the barter economy, the search for acceptable terms of trade is avoided. As a result, in a monetary economy productive efficiency is expected to increase.

Implications of real money balances as a factor of production are:

1. Money would have a marginal physical productivity schedule like other inputs;
2. Firms' demands for real money balances would be derived in the same way as other factor demand functions;
3. Changes in the stock of real money would affect real output, contrary to the classical dichotomy which implies the neutrality of money;
4. Traditional analysis of production would be subject to modification;
5. Real balances might explain some of the rate of growth of total productivity of the residual.

Hisnanick and Kymn 1990) Others have examined cost function and have reported cost minimizing cross price elasticities. (Dennis and Smith 1978; Mahmud 1990) Both these approaches have some limitations in estimating the production function. levels of inputs appear as right hand side variables which may not be truly exogenous. Estimation of cost function is preferred as prices appear as right hand side variables. And in the context of manufacturing firms, it is reasonable to assume that these prices can be taken as exogenous. However, price elasticities obtained from this framework are cost minimizing elasticities with output being exogenous. Use of profit function avoids both of these problems. On the one hand prices appear as explanatory variables and on the other price elasticities are output variable elasticities. Profit functions have some other advantages over production functions. It is possible to derive the supply function and the factor demand functions directly from an arbitrary profit function without an explicit specification of the corresponding production function. This is a great advantage for flexibility in empirical analysis. We can derive factor demand functions and output supply function directly from profit function, this facilitates interpretation and analysis for deriving macro policy implications. For example, Harkness (1984) and Jansen (1985) argued that real balances provide a link between real output and the nominal interest rate on the aggregate supply side of the economy. In the literature, however, not much has been explored regarding the macroeconomic supply-side effects of the real money balances via the production function approach. In a similar context, Dennis and Smith (1978) have argued that motives for holding money balances by individual households may be quite different from that of the firms and, therefore, the use of a single equation to represent the demand for money for both these groups in the macroeconomic models would be "too much of a compromise of the theory".

We restrict capital to be a quasi-fixed input. In this thesis we also show the derivation of short-run and long-run elasticities in the context of translog profit function.

We analyze Canadian aggregated and disaggregated manufacturing data to estimate the model and compute the short and long run elasticities.

The organization of the thesis is as follows:

Chapter 2 presents a review of the literature for real money balances in production function. Chapter 3 discusses the methodology including the model employed and derivation of elasticities. Chapter 4 introduces the data and estimation procedure. Chapter 5 discusses the results and finally Chapter 6 provides the conclusion.

CHAPTER 2

LITERATURE SURVEY

This chapter presents a literature survey of real money balances in the production function. First a historical review will be given with reference to the work of Sinai and Stokes (1989) who made the first emprical study on this subject. Secondly, two theoretical models by Stanley Fischer (1974) will be presented which provide theoretical justification of money in production function. Finally, the studies using flexible functional forms will be examined.

2.1 Historical Review

Sinai and Stoke (1989) survey the literature for real balances in production function and reply to the issues raised in some papers. A major motivation of the research concerning real money balances as a factor of production is to attempt to capture the effects of changes in financial policies on real output. Unlike the markets for labor and capital, which in theory do not contain constraints, the creation of the money supply is restricted by institutional and legal arrangements. The question becomes, "How optimum is the money supply?" Presumably, with optimum the money supply the level of output is greater; because firms will optimally hold more real balances. Friedman (1969, p.34) has a definition for the optimum quantity of money: "Our final rule for the optimum quantity of money is that it will be attained by a rate of price deflation that makes the nominal rate of interest equal to zero."

The development of the financial system is an important determinant of economic growth. The empirical research to date has been concerned with attempting to measure some aspects of this financial development. Sinai-Stokes (1972) were the first to add real balances, defined as m1, m2 and m3, to a production function for annual data for the United States from 1929 to 1967. In this early work, Sinai-Stokes (1972) used second-order GLS to estimate a Cobb-Douglas production function containing real balances. Sinai-Stokes (1975, 1977) replied to a number of critics. These included Niccoli (1975), who argued for investment in the production function rather than real balances; Prais (1975a, 1975b), who suggested that the results obtained in the Sinai-Stokes (1972) paper were due to differencing the monetary variable, and Khan-Kouri (1975), who supported Sinai and Stokes' findings with the estimation of a simultaneous equations model. Sinai Stokes (1975) raised some questions concerning a number of problems in Khan-Kouri (1975) that include making capital and labor exogenous and the form of the money demand equation used. Ben-Zion and Ruttan (1975) provided a further comment on Sinai-Stokes' work, where they proposed an alternative specification of the production function that contained real balances as an input and the percent change in real balances as a shift parameter. Their finding was that the "rates of change in the real money supply seem to have stronger and more significant effects than the level of real balances. This is clearly consistent with the induced innovation approach, but not with the production approach." Sinai-Stokes (1975) had problems replicating their findings empirical and theoretical problems with their interpretation of the specification used.

Additional theoretical work in the early 70s included Pierson (1972), who argued for a more broader definition of the monetary aggregate, and Moroney (1972) who argued that "It may seem justifiable to include real balances as an input of an aggregate production function" but commented, "The sources of the productivity of money are not clearly enough exposed."

Further emprical evidence concerning the role of real balances in production function included an important paper by Short (1979). This work used a more general translog production function to find evidence for real balances in the production function when the model had been corrected for any possible simultaneity bias. This work is viewed as more comprehensive than that of Khan-Kouri (1975). Additional simultaneous equations results were provided by Butterfield (1975), who found real balances were a significant input in a Diewert generalized Leontief production function. Later work on the original Sinai-Stokes (1972) data included Subrahmanyam (1980), who developed a translog production function model for the period 1947-1967 and found evidence for real balances. In related work, Simos (1981) studied the problem using further revisions of the data over the period 1929-1972 and the translog production function. His major finding was "rejection of the hypothesis that the hardware relation between capital and labor is independent of the level of real balances." His further findings were that "Real balances are substitutes for capital but complements with labor," and that "Real money balances do contribute to the aggregate supply. Thus the theoretical and empirical foundations of existing models should be carefully re-examined." The above works support the assertion that real balances are a significant input in alternative production functions that have been corrected for possible simultaniety problems.

Boyes-Kavanaugh (1979) argued for the CES form of the production function instead of the Cobb-Douglas form used by Sinai-Stokes (1972). Sinai-Stokes (1981b) argued that Boyes-Kavanaugh (1979) mistakenly estimated their CES model conditionally. Sinai-Stokes (1981b) estimated a CES model using nonlinear methods with and without time and with and without GLS corrections, and found real balances were a significant input in the production function. In addition, new data containing quarterly data on the nonfinancial corporate sector 1953:1 to 1977:3 was used to show that real balance significantly enter a Cobb-Douglas production function in which real balances were defined as m1, m2 and FA (real financial assets held by nonfinancial corporations), respectively. In Sinai-Stokes (1981a), Japanese data were used to estimate an aggregate production function containing labor, capital and real money balances for annual data in the period 1952-1968. Real balances were found to be significant input in the production function, and in this paper, Sinai-Stokes extend the results of Nguyen (1986) who argued for subperiod effects using a new data series. No evidence was found for entering real balances as a shift parameter, as was suggested by Moroney (1972).

The above research supports the addition of real balances in an aggregate production function to capture the effect of the financial sector on real output. In related research, Neuburger-Stokes (1975, 1976, 1978) tested the important insights of Gerschenkron (1962) on the effect of changes in the financial system on output. Gerschenkron's (1962, p. 46) hypothesis was that the backward countries that experience successful industrialization do so by making industrial substitutions that enable them to compansate for their initial deficiencies of productive inputs. Neuburger-Stokes (1974) choose to investigate the role of the Credit Banks in Germany in the period 1883-1913. Over this period, the influence of the Credit Banks on certain industrial sectors was growing. This was typified by 1905 when the eight major Credit Banks' influence on industry had grown to 819 directors of industrial firms. The German financial system involved a system in which the Credit Banks made long-term loans at short-term rates to those industrial firms on which they had influence in the form of directors. The net effect of this institutional arrangement was to bias the capital market toward the favored firms by giving them long-term loans at short term rates. A measure of this bias was current account credit extended by banks in this manner (CA) divided by total credit extended by banks for productive purposes (MB). Neuburger-Stokes (1974) chose to model this effect by estimating a production function containing labor (L) and capital (K) as inputs, and time (V_1) and various lags of (CA/MB) as $V_2, \ldots, V_n$ of the form:

$$Q = Ae^{\delta} L^{\alpha} K^{\beta} e \qquad (2.1.1)$$

where $\delta = \mu_1 V_1 + \mu_2 V_2 + \ldots + \mu_n V_n$.

If there was a negative effect on output arising from the bias in the financial market, some of the values of $\mu_2, \ldots, \mu_n$ would be negatively significant. Neuburger-Stokes (1974) found such effects for Germany. It should be noted that Gerschenkron argued for positive effects, and in his analysis neglected the dead weight loss to the economy of a discriminatory capital market. Neuburger-Stokes (1975) tested basically the same model for Japan in the period 1952-1968. Here the negative effects found for Germany were not observed. In the Japanese model, the level of imported technology was explicitly modelled as an additional shift parameter. Neuburger-Stokes (1975) argue that Japan allowed the banking system to obtain influence on certain industries, and rationed the importing of technology to counter the output loss associated with the bias in the capital market.

Unlike many of the other writers who have used the original Sinai-Stokes (1972) data set, Nguyen (1986) uses the data set (1930-1978). His paper argues that in some subperiods, real balances were not significant in the production function and that the correct specification of the model should be

$$\ln Q = \ln A + \theta + \Gamma(\delta m / m)t + \alpha \ln L + \beta \ln K + \tau \ln m + u \qquad (2.1.2)$$

where $(\delta m / m) = (m_t - m_{t-1}) / m_t$. Specially, while Nguyen finds real balances are significant in the period 1930-1967, and in the period 1947-1967 he finds that money, either as m1 or m2, is not statistically significant in regressions with or the without the time trend. In the more recent period 1947-1978, m2 is only significant in models without the trend. Although it is possible that in the period 1929-1967. the financial system may have changed in ways not captured by m1 or m2 and time, the subperiods 1947-1967 and 1947-1978 contain only 21 and 32 observations, respectively, which may not be sufficient for models with six independent variables. They estimate the Nguyen's data for the period 1930-1978 to investigate the complete period. What is remarkable is that in the models that do not contain time, the coefficient on real balances is relatively stable.

It appears clear that there have been shifts in the structure of the economy that are not captured fully by the variables in the equation (2.1.2). The relationship between real balances, which is a proxy for the financial sector, and time, which is a proxy for technological change although the change, is changing, although the change is not yet significant as measured by the CUSUMSQ test. This finding suggests that Nguyen's attempt to reformulate the model is a useful approach.

Although many writers such as Levhari-Patinkin (1968), Johnson (1969), Friedman (1969), and Bailey(1962, 1971), argued for real balances in the production function, others such as Pierson (1972), and Fischer (1974), raised questions concerning what was being measured by real balances. While Pierson (1972, p. 389) argued that the "appeal of the theory that money belongs in the production function is that it offers a way for monetary growth to affect the real balances in the system," she later noted that "credit should also be included..." Her main objection was that a production function model containing real balances neglects "the effects of the credit system or a financial intermediary system and thus claim too much for money." Moroney (1972, p. 342) makes a similar point arguing "..it may seem justifiable to include real balances as an input of an aggregate production function. Yet by doing so the sources of the productivity of money are not clearly enough exposed. It seems well worthwhile to consider them in more detail than is suggested simply by including real balances as an ordinary input." Fischer (1974) while commenting on Sinai-Stokes (1972) work, noted, "The question here is again whether real balances are an adequate index of the resources used in transacting. This is unlikely ... if there is technical progress in transactions which is not explicitly modelled."

Benzing's study applied an unconstrained Cobb-Douglas production function to United States annual data from 1959-1985 to ascertain whether real money is a significant determinant of national output. In the Cobb-Douglas production function, output is a function of labor, capital, real money balances and time (which serves as a proxy for technological change). With or without the inclusion of time, money was found to be significant whether expressed as real m1, m2, m3 or nonfinancial business demand deposits and currency.

The production function was also examined with the change in real money balances, instead of the absolute amount of real money balances, as an independent variable. In this formulation, the only significant money variable was the change in real m3. Money was also found to be significant in a Cobb-Douglas production function with homogeneity restrictions.

Previous studies may have achieved mixed results because the old definitions of m1 and m2 were used. In contrast, this study uses more recent data and tests a broader range of money variables.

The results of this study are in contrast with the results obtained by Nguyen (1986). Although the same K and L variables were used over a slightly more recent time period, Nguyen (1986) found that real m1 and m2 were never significant, in either the unrestrained Cobb-Douglas or the Cobb-Douglas with homogeneity restrictions, when time was included. The difference in results may lie in the specifications of m1 and m2. Nguyen (1986) used the Federal Reserve's old definition of both m1 and m2, while this study utilized the U.S. Federal Reserve's new definition of m1 and m2. Although the difference is not great between old and new m1, the difference between old and new m2, is substantial. Nguyen (1986) included currency, demand deposits, and small time and savings deposits. In contrast, new m2 includes overnight repurchase agreements, overnight Eurodollars, noninstitutional money market mutual fund shares, and money market deposit accounts. This broader measure of money includes business deposits which appear to significantly influence the aggregate production function. Therefore, this study concludes that money is a significant determinant of aggregate production, and that Nguyen's results (1986) may be due to his misspecification of the money variable.

In Jensen-Kamath-Bennett's paper (1987), authors examine the debate over the inclusion of real money balances in the neoclassical aggregate production function and propose an alternative test procedure to rigorously test the original Sinai and Stokes (1972) hypothesis. The alternative procedure provides a logically complete extension of the existing conventional procedures by identifying four possible types of test outcomes obtained by testing both the theory under consideration and a valid counter example of the theory.

They apply the alternative test procedure to the Sinai and Stokes hypothesis by developing a counter example of a "money-deflated" production function. They test both a restricted and an unrestricted version of their counter example and their results indicate that both the original Sinai and Stokes formulation and the counter example pass identical confirmation tests. These results put into question Sinai and Stokes' claim of success for their original hypothesis.

It is important to note that they test only for the Cobb –Douglas specification originally used by Sinai and Stokes. Other specifications would require the similiar development of valid counter examples and reapplication of the test procedure. Since the debate over the inclusion of real money balance as a factor input in the aggregate capital and money are complements are what one would expect given a priori economic reasoning. Similarly, the conclusion that labor and energy are complements is again substantiated via economic reasoning, in that a rise in the price of energy will lead to a fall in the demand for labor. In addition, the same a priori reasoning can be used to support the conclusion that labor and money are substitutes within the production process. The emprical conclusion that energy and money are substitutes cannot be readily explained using economic reasoning. This has resulted in the arriving at the belief that further study may be warranted. That is, to investigate the possible implications of a disaggregated energy component: one composed of an electric energy component and a non-electric energy component. Such a study could possibly show that the effect of substitutability is overshadowing the complementarity with respect to the input factor money.

However, the emprical findings of the relative highly inelastic cross price elasticities between capital and money, labor and money and energy and money leads to conclude that one can view money as an essential input into the production process of the U.S. Manufacturing sector. In addition, the relative highly inelastic cross price elasticities between labor and energy and energy and money and the relative inelastic cross price elasticity between capital and energy imply that energy can also be viewed as an essential input into the production process of the U.S. Manufacturing sector.

In Benhabib–Farmer's Paper (1996) paper, authors take it as given that market economies are characterized by a set of stylized responses to increases in the stock of money. Innovations to the stock of money lead to increased output and reductions in short-term interest rates in the short run and only in the long run do nominal prices respond. Most authors have attributed the real effects of money in the short run either to mistaken expectations or to non-market clearing or both. In this paper authors argue that neither of these channels is needed to explain the facts. They show that a competitive market clearing model in which money enters the production function is fully capable of mimicking the broad features of the data. Their argument relies on an explanation of "price stickiness" that exploits a multiplicity of equilibria in a rational expectations model.

Palley's Paper (1996) shows how the mechanisms of endogenous growth can readily be incorporated within old growth theory, thereby resolving the principal impasse that stymied old growth theory. The key mechanism is the technological progress function which was originally developed by Kaldor (1957). The growth effects of monetary and fiscal policy operate through three channels. The first is the 'portfolio composition' channel, with policy serving to alter the money-capital mix of portfolios; the second is the money in the production function channel, with policy serving to alter the relative use of money and capital as inputs; the third is the money in the technological progress function channel, with policy affecting the dynamic allocative efficiency of investment via its impact on the level of financial intermediation. Since money and capital both enter the technological progress function, policies that affect the demands for money and capital affect the steady state rate of growth.

2.2 Theoretical Models

One of the most interesting papers for the subject is Fischer's paper (1974). Fischer states that to treat real balances as a factor of production is a dangerous procedure. He claims money enters a firm's production function if that firm's activities which include both production and exchange can be described as if it is maximizing profits subject to constraint of a production function that includes real balances, that constraint is:

$$y = g(x, M/P, v) \qquad (2.2.1)$$

Where y is output, x is physical input vector, M/P is real balances and v is some vector of other inputs, where x and M/P have positive marginal products.

In his paper Fischer deals with two models:

1. Baumol-Tobin Model:

In Baumol-Tobin Model cash is held only because it is cheaper to hold it temporarily than to buy bonds. This model shows that the mere fact that a firm holds money does not mean that money is a factor in the sense defined in (2.2.1), and holding of real balances economizes on the use of other factors.

$$y(t) = f(x(t)) \qquad (2.2.2)$$

where x:input flow and y:output flow.

Goods can be sold at a fixed price P, factor is hired at a rental rate, w. The accrued cash can be held either as cash earning simple interest at the rate r_m (possibly negative) or transferred at a fixed cost of transaction into bonds, paying simple interest at the rate $r_b > r_m$, at the end of period all bonds are transferred into money, at cost "c".

Let T be the lenght of period and $R = pf(x) - wx$, then profit can be written as:

$$\Pi_t = R\sum_{j=1}^{n}\left[(1 + r_b(T - t_j))(t_j - t_{j-1}) + \frac{r_m}{2}(t_j - t_{j-1})^2\right] - nc \qquad (2.2.3)$$

where $t_n = T$ and $t_0 = 0$.

Then firm chooses $t_1, t_2, ..., t_{n-1}$.

If we solve the model with average cash $\overline{M} = \frac{R}{2n}$ and average bond $\overline{B} = \frac{R(n-1)}{2n}$, we get profit as:

$$\Pi = R + r_m \overline{M} + r_b \overline{B} - nc\,. \qquad (2.2.4)$$

Real balances are a factor of production because firms hold them at a cost in terms of foregone interest, but not in the sense of equation (2.2.1). The transformation set that describes the technology of the firm:

$$T(Y, \overline{B}/R, \overline{M}/R, x, n) = 0 \qquad (2.2.5)$$

Existence of (2.2.5) does not imply the existence of a production function including real balances. Firm's profit maximization is a two-step procedure:

In the first step profits from physical production are maximized and profits from financial management are maximized at the second step. So real balances are not a factor of production in the sense defined in equation (2.2.1).

Then author assumes that the firm makes its own transactions between money and bonds, and that the transaction costs represent the cost of hiring labor, $c = w$. Then he derives production function:

$$Y = g(x, \overline{M}/R) \qquad (2.2.6)$$

which includes real balances. If firm knew only (2.2.6), it would not know at what time to transfer money into bonds. But this is no different from the production function economists usually use: to know that a physical production function is Cobb-Douglas is not to know to run a factory.

2. Vending Machine model:

In previous model the firm never needs money, there is no cost to it of running out of cash. Here the firm produces a perishable output one day and puts it into a machine next day. Any output unsold at the end perishes.

At time $t+1$ output $y(t)$ is sent to the machine where it is sold at price p. At price p a number of customers $Q(p)$ will visit the machine during the day. With probability q an individual will have the correct change of p and will purchase one unit of the good if it is available. With probability $(1-q)$ he will have only a $2p$ coin and will buy only if the machine has change of p and a stock of the good left.

In the production and sales cycle the firm has to choose the output $y(t)$ and initial cash balance M_{t+1}, denominated in units of p. Let S be expected sales:

$$S = S(y_0, z_0, Q) \qquad (2.2.7)$$

where z_0 is the money in units of $1p$ at time 0. When we solve model, we realize that: The firm acts as if it is maximizing expected sales function which satisfies the form of equation (2.2.1). Thus we again have a production function including real balances.

The function $S(f(x), z_0, Q)$ should be regarded as the production function for goods which are actually bought by the consumer, while the function $f(x)$ is the physical production function. $S(.)$ is the delivered production function and it is production which actually reaches the consumer rather than physical production which affects his welfare.

More general delivered production functions could be derived where alternative models of the sales process and, the role of cash in it, are postulated. So long as the firm is penalized for being short of cash, real balances will be a factor in delivered production function.

So as a conclusion of Fischer's paper we see that real balances are different from other factors of production. The land, labor, seeds and machines which produce wheat would produce the same amount of wheat whatever market arrangements and prices are. In contrast real value of nominal balances can not be defined without knowing prices.

Theories of demand for money usually imply a deterministic time path of holding of money. Thus there will be no simple relation between holdings of money at each instant and the firm's output.

We are not used to production functions which involve uncertainty in a essential way, while the most convincing models of the demand for money are based on the presence of uncertainty. A stochastic cash flow is postulated and the firm chooses its optimal portfolio in relation to this flow. It does not, however, adjust its production pattern in a way which depends on and can affect the cash flow. Vending machine model overcomes this problem.

2.3 Translog Cost Function Model

In his paper Mahmud (1993) examined if real balances included in production function. In the framework money is not held for its own sake but as an intermediate good for services, so it can be included in the production function.

His emprical study is done on Canadian manufacturing sector data. He uses a translog cost function approach.

$$\ln(C) = \alpha_0 + \alpha_q \ln Q + \frac{1}{2}\gamma_{qq}(\ln Q)^2 + \sum_i \alpha_i \ln P_i + \frac{1}{2}\sum_i \sum_j \gamma_{ij}(\ln P_i)(\ln P_j)$$

$$+ \sum_i \gamma_{qi}(\ln Q)(\ln P_i) \qquad (2.3.1)$$

where Q is the real output, P_i's are the factor prices of capital,skilled labor, unskilled labor and real balances.

So instead using production function, he uses the dual cost function. Zellner's unrelated estimation technique has been used to estimate the cost function with three share equations which are:

$$S_i = \alpha_i + \gamma_{qi} \ln Q + \sum_i \gamma_{ij} \ln P_i \qquad (2.3.2)$$

where i,j=k,s,u,m and S_i indicates the cost share of i^{th} factor input. He obtains S_i's by

$$\frac{\partial \ell nC}{\partial \ell nP_i} = \frac{\partial C}{\partial P_i} \times \frac{P_i}{C} = X_i \times \frac{P_i}{C} = S_i \qquad (2.3.3)$$

He estimates four versions of the model by dropping one share equation each time. In most cases the estimated parameters are siginificantly different then zero at the 95% level of confidence.

As expected he finds that the own-price elasticities of demand for the facrors are negative. The signs of the cross price elasticities of capital with respect to money and non-production labor workers with respect to money are positive. And the elasticity for the production workers is negative. So capital and non-production workers are subtitutes to money and production workers are complementary to money.

Another interesting result is the relative high substitutability between real balances and capital, this result seems fairly intitutive when money is considered to be a working capital.

As a conclusion real cash balances are indeed important factors of production for the aggregate Canadian manufacturing sector. This does not mean that real money balances are like other any other factors of production. Own and cross price elasticities estimates suggest that the demand for real balances, production worker and capital are inelastic and that the production workers and money appear to be complements to each other and money seems to be a substitute for capital and non-production workers.

Another study for real balances in production function using a translog cost function is made by Betancourt and Robles (1989). The main contribution of this paper is the development and implementation of a simple but critical test of the role of financial variables in production. The test is based on a restricted cost function. Implementation was carried out in terms of a translog functional form estimated by nonlinear three stage least squares. The main data base was constructed by augmenting the manufacturing sector data developed by Berndt and Wood with information on the financial variables from the Federal Reserve Flow of Funds series.

Undoubtedly, the most robust conclusion to emerge from the analysis is that both financial variables together, credit and money, are statistically important in the determination of the costs of producing output. This result holds true for both definitions of credit and with all instruments matrices; therefore, it provides strong emprical support for the recent theoretical interest in linking financial and real variables at both the micro and macro levels.

A somewhat less robust conclusion that emerge from their analysis is that neither money nor credit should be viewed as an input in the production process. The sign of the elasticity of costs with respect to money or credit is inconsistent with either variable being an input for at least fourteen or seventeen data points, respectively, in each of the four cases considered. Moreover, in three out of possible four cases, the null hypothesis that credit is an input is rejected for at least one data point. With respect to money, however, the results are slightly weaker. Namely, in two out of four cases the null hypothesis that money is an input is rejected for at least one data point. Interestingly enough, both cases occur with the broad definition of credit.

Given the sensitivity of the results on the role of money to the definition of credit, a noteworthy implication of the analysis is that attempts to discriminate emprically between "credit theory" and "money theory" and to pay special attention to the emprical definition of credit implied by a particular model. It must also be pointed out that Betancourt and Kiguel (1988) generate the demand for credit by the firm out of the need for working capital, which suggests that the broad definition of credit is the appropriate one. This view is also consistent with the macroeconomic argument by Brunner and Meltzer (1988) that loan rationing is not the only mechanism in the propagation of monetary impulses and that one should include a spectrum of assets and liabilities. Nonetheless it must be concluded that the emprical results do not provide compelling evidence on the choice between the two definitions of credits.

CHAPTER 3

THE METHODOLOGY

3.1 The Profit Function Model

Many people used production function models to determine if real money balances enters production function as a factor, such as Cobb-Douglas production function, translog production function. A neoclassical production function can be written as:

$$y = f(x, K) \tag{3.1.1}$$

where y is output vector, x is a vector of inputs and K is a vector of quasi-fixed factors. A production function considers labor and capital as exogenous, but econometrically they are not truly exogenous. In firm level, it is easy to assume that prices are exogenous. So instead using labor and capital directly, we can use their prices. A cost function assumes output as fixed, so this model cannot make interpretations if output varies.

Instead of using a production function model, we use a profit function model. Profit function takes output as variable and uses prices of the factors in model instead factors. Normalized restricted profit functions have some advantages over production functions. In their paper Sidhu and Baanante (1979) state that:

> "...first, because it is a function of only of predetermined variables and thus econometrically more appropriate for estimation, and second, because the system of factor demand functions and output supply function obtained from the normalized restricted profit function facilitates interpretation and analysis for deriving policy implications."

Also Lau and Yotopoulos (1972) summarize the advantages of a restricted normalized profit function as:

> "... first, the Shephard's Lemma makes it possible to derive the supply function and the factor demand functions directly from an **arbitrary** unit-output-price profit function, which is decreasing and convex in the normalized prices of the variable inputs and increasing in the fixed inputs, without an explicit specification of the corresponding production function. This provides a great deal of flexibility in empirical analysis. Second by starting from a profit function, it is assured by duality that the resulting system of supply and factor demand functions is obtainable from profit maximization of a firm with a production function concave in the variable inputs subject to given fixed inputs and under competitive markets. Third, the profit function, the supply function, and the derived demand functions so obtained may be explicitly written as functions of variables that are normally considered to be determined independently of the firm's behavior. Econometrically, this implies that these variables are exogenous variables. By estimating these functions directly the problem of simultaneous equations bias to the extent that it is present can be avoided."

There is one-to-one correspondence between production function and the related normalized, restricted-profit function (Lau, 1976). Normalization is done by dividing the profit function by the price of output. A normalized profit function can be expressed by:

$$H\left(r^{*},K\right)=\frac{\pi(.)}{p} \tag{3.1.2}$$

where p is the price of output, r^{*} is normalized input prices, K is as defined before and $\pi(.)$ is the profit function which can be defined as:

$$\pi\left(p,r;K\right)\equiv\max_{xy}\left\{py-rx;\left(y,x;K\right)\in T\right\} \tag{3.1.3}$$

where y is vector of outputs, x is vector of inputs and T is a closed, bounded, strictly convex set of all feasible combinations of inputs and outputs, i.e., a production possibility set. Lau (1976) gives some properties of a restricted normalized profit function as:

1. *Domain:* The effective domain of $H(y^*,K)$ is a convex set containing the origin. $H(0,0)=0$.
2. *Closure:* $H(y^*,K)$ is lower-closed.
3. *Convexity-concavity:* $H(y^*,K)$ is convex in y^* for every K and concave in K for every y^*.
4. *Nonnegativity-nonpositivity:* $H(y^*,0)$ is nonnegative; $H(0,K)$ is nonpositive.

Also a restricted normalized profit function is assumed to be linearly homogenous, and monotonic in prices.

Given a normalized profit function, the original production function can be recovered by the conjugacy operation (Diewert, 1973; Lau, 1976). The duality between profit and production functions implies that properties of production technology and choice are fully described by profit function and demand functions. Specially, the technological properties of homotheticity, homogeneity and separability have specific implications for the form of the expected profit and demand equations. The demand functions for the variable factors of production are obtained by differentiating the normalized profit function with respect to the respective normalized factor prices (if we assume the profit function is twice continuously differentiable with respect to prices, applying Hotelling's Lemma):

$$X_i = -\frac{\partial \pi^*}{\partial p_i} \qquad (3.1.4)$$

where 'i' stands for the inputs.

3.2 The Translog Profit Function Model

In the absence of a correct and a priori information on specific functional form underlying the production, a translog form may be used more conveniently. The profit is expressed as a function of variable input prices and quantities of fixed inputs. In this section a transcendental logarithmic (translog) profit function will be presented. In its most general form a translog profit function can be expressed as:

$$\ln \pi = \alpha_0 + \sum_i \alpha_i \ln P_i + \frac{1}{2}\sum_i \sum_h \gamma_{ih} (\ln P_i)(\ln P_h) + \sum_i \sum_k \delta_{ik} \ln P_i \ln Z_k + \sum_k \beta_k \ln Z_k$$

$$+\frac{1}{2}\sum_k \sum_j \phi_{kj} \ln Z_k \ln Z_j \tag{3.2.1}$$

where P_i's are price of netputs (both inputs and outputs) and Z_k's are fixed factors and π is the profit.

This translog profit function has to be normalized, and symmetry and restrictions have to be imposed. In next section we will derive a normalized restricted translog profit function in which symmetry and restrictions are imposed.

3.3 Translog Model for Real Balances in Production Function

In this section the model that will be used through the thesis will be obtained. In the model we have three inputs, which are skilled labor (non-production labor), unskilled labor (production labor) and money and P_s, P_u and P_m are prices of these inputs, respectively. Capital is a fixed factor, K. Finally P_y is the price of output. The model is:

$$\ln \pi = \alpha_0 + \alpha_y \ln P_y + \alpha_u \ln P_u + \alpha_s \ln P_s + \alpha_m \ln P_m + \frac{1}{2}\gamma_{yy}(\ln P_y)^2 + \frac{1}{2}\gamma_{uu}(\ln P_u)^2$$

$$+\frac{1}{2}\gamma_{ss}(\ln P_s)^2+\frac{1}{2}\gamma_{mm}(\ln P_m)^2+\gamma_{yu}(\ln P_y)(\ln P_u)+\gamma_{ys}(\ln P_y)(\ln P_s)+\gamma_{ym}(\ln P_y)(\ln P_m)$$

$$+\gamma_{us}(\ln P_u)(\ln P_s)+\gamma_{um}(\ln P_u)(\ln P_m)+\gamma_{sm}(\ln P_s)(\ln P_m)+\beta_k\ln K+\delta_{yk}(\ln P_y)(\ln K)$$

$$+\delta_{uk}(\ln P_u)(\ln K)+\delta_{sk}(\ln P_s)(\ln K)+\delta_{mk}(\ln P_m)(\ln K)+\frac{1}{2}\delta_{kk}(\ln K)^2 \tag{3.3.1}$$

Using this model we can derive shares equations for output and inputs. Those will be the profit shares of the factors. The shares can be defined as $S_i=-\frac{P_iX_i}{\pi}$ where i stands for input factors, and $S_y=\frac{P_yQ}{\pi}$ is the output share where Q is the real value of output.

Let S_u, S_s and S_m be the shares of unskilled labor, skilled labor and money respectively. We can obtain these shares as:

$$S_i=\frac{\partial\ln\pi}{\partial\ln P_i}=\frac{\partial\pi}{\partial P_i}\frac{P_i}{\pi}=-X_i\frac{P_i}{\pi} \tag{3.3.2}$$

for $i=y,u,s,m$

So the shares are:

$$S_y=\alpha_y+\gamma_{yy}\ln P_y+\gamma_{yu}\ln P_u+\gamma_{ys}\ln P_s+\gamma_{ym}\ln P_m+\delta_{yk}\ln K \tag{3.3.3}$$

$$S_u=\alpha_u+\gamma_{uu}\ln P_u+\gamma_{us}\ln P_s+\gamma_{um}\ln P_m+\gamma_{yu}\ln P_y+\delta_{uk}\ln K \tag{3.3.4}$$

$$S_s=\alpha_s+\gamma_{ss}\ln P_s+\gamma_{us}\ln P_u+\gamma_{sm}\ln P_m+\gamma_{ys}\ln P_y+\delta_{sk}\ln K \tag{3.3.5}$$

$$S_m=\alpha_m+\gamma_{mm}\ln P_m+\gamma_{um}\ln P_u+\gamma_{sm}\ln P_s+\gamma_{ym}\ln P_y+\delta_{mk}\ln K \tag{3.3.6}$$

The shares have to add up to unity. That is:

$$S_y+S_u+S_s+S_m=1 \tag{3.3.7}$$

So the system is singular, because of (3.3.7). We have to drop one of the share equations. If we add all shares and combine similar terms, we can get the restrictions:

$$1=(\alpha_y+\alpha_u+\alpha_s+\alpha_m)+(\gamma_{yy}+\gamma_{yu}+\gamma_{ys}+\gamma_{ym})\ln P_y+(\gamma_{yu}+\gamma_{uu}+\gamma_{us}+\gamma_{um})\ln P_u$$

$$+(\gamma_{ys}+\gamma_{us}+\gamma_{ss}+\gamma_{sm})\ln P_s+(\gamma_{ym}+\gamma_{um}+\gamma_{sm}+\gamma_{mm})\ln P_m+(\delta_{yk}+\delta_{uk}+\delta_{sk}+\delta_{mk})\ln K$$

Restrictions:

$\alpha_y+\alpha_u+\alpha_s+\alpha_m=1$ that is $\alpha_y=1-\alpha_u-\alpha_s-\alpha_m$ (3.3.8)

$\gamma_{yy}+\gamma_{yu}+\gamma_{ys}+\gamma_{ym}=0$ $\gamma_{yy}=-\gamma_{yu}-\gamma_{ys}-\gamma_{ym}$ (3.3.9)

$\gamma_{yu}+\gamma_{uu}+\gamma_{us}+\gamma_{um}=0$ $\gamma_{yu}=-\gamma_{uu}-\gamma_{us}-\gamma_{um}$ (3.3.10)

$\gamma_{ys}+\gamma_{us}+\gamma_{ss}+\gamma_{sm}=0$ $\gamma_{ys}=-\gamma_{us}-\gamma_{ss}-\gamma_{sm}$ (3.3.11)

$\gamma_{ym}+\gamma_{um}+\gamma_{sm}+\gamma_{mm}=0$ $\gamma_{ym}=-\gamma_{um}-\gamma_{sm}-\gamma_{mm}$ (3.3.12)

$\delta_{yk}+\delta_{uk}+\delta_{sk}+\delta_{mk}=0$ $\delta_{yk}=-\delta_{uk}-\delta_{sk}-\delta_{mk}$ (3.3.13)

Inserting these restrictions into (3.3.1):

$$\ln\pi=\alpha_0+(1-\alpha_u-\alpha_s-\alpha_m)\ln P_y+\alpha_u\ln P_u+\alpha_s\ln P_s+\alpha_m\ln P_m$$

$$+\frac{1}{2}(-\gamma_{yu}-\gamma_{ys}-\gamma_{ym})(\ln P_y)^2+\frac{1}{2}\gamma_{uu}(\ln P_u)^2+\frac{1}{2}\gamma_{ss}(\ln P_s)^2+\frac{1}{2}\gamma_{mm}(\ln P_m)^2$$

$$+(-\gamma_{uu}-\gamma_{us}-\gamma_{um})(\ln P_y)(\ln P_u)+(-\gamma_{us}-\gamma_{ss}-\gamma_{sm})(\ln P_y)(\ln P_s)$$

$$+(-\gamma_{um}-\gamma_{sm}-\gamma_{mm})(\ln P_y)(\ln P_m)+\gamma_{us}(\ln P_u)(\ln P_s)+\gamma_{um}(\ln P_u)(\ln P_m)$$

$$+\gamma_{sm}(\ln P_s)(\ln P_m)+\beta_k\ln K+(-\delta_{uk}-\delta_{sk}-\delta_{mk})(\ln P_y)(\ln K)+\delta_{uk}(\ln P_u)(\ln K)$$

$$+\delta_{sk}(\ln P_s)(\ln K)+\delta_{mk}(\ln P_m)(\ln K)+\frac{1}{2}\delta_{kk}(\ln K)^2 \qquad (3.3.14)$$

From equations (3.3.10), (3.3.11) and (3.3.12) we can derive:

$$-\gamma_{yu}-\gamma_{ys}-\gamma_{ym}=\gamma_{uu}+\gamma_{ss}+\gamma_{mm}+2\gamma_{us}+2\gamma_{um}+2\gamma_{sm} \qquad (3.3.15)$$

If we arrange (3.3.14) by using (3.3.15), we get:

$$\ln \pi = \alpha_0 + \ln P_y + \alpha_u \ln \frac{P_u}{P_y} + \alpha_s \ln \frac{P_s}{P_y} + \alpha_m \ln \frac{P_m}{P_y} + \frac{1}{2}\gamma_{uu}\left(\ln \frac{P_u}{P_y}\right)^2 + \frac{1}{2}\gamma_{ss}\left(\ln \frac{P_s}{P_y}\right)^2$$

$$+ \frac{1}{2}\gamma_{mm}\left(\ln \frac{P_m}{P_y}\right)^2 + \gamma_{us}\left(\ln \frac{P_u}{P_y}\right)\left(\ln \frac{P_s}{P_y}\right) + \gamma_{um}\left(\ln \frac{P_u}{P_y}\right)\left(\ln \frac{P_m}{P_y}\right) + \gamma_{sm}\left(\ln \frac{P_s}{P_y}\right)\left(\ln \frac{P_m}{P_y}\right)$$

$$+ \beta_k \ln K + \delta_{uk}\left(\ln \frac{P_u}{P_y}\right)(\ln K) + \delta_{sk}\left(\ln \frac{P_s}{P_y}\right)(\ln K) + \delta_{mk}\left(\ln \frac{P_m}{P_y}\right)(\ln K) + \frac{1}{2}\delta_{kk}(\ln K)^2$$

In the derivation, the term $(\ln(P_u/P_y))(\ln(P_s/P_y))$ is obtained as:

$$\left(\ln \frac{P_u}{P_y}\right)\left(\ln \frac{P_s}{P_y}\right) = (\ln P_u - \ln P_y)(\ln P_s - \ln P_y)$$

$$= (\ln P_y)^2 - (\ln P_y)(\ln P_u) - (\ln P_y)(\ln P_s) + (\ln P_u)(\ln P_s)$$

Finally restricted normalized translog profit function is:

$$\ln \pi^* = \alpha_0 + \alpha_u \ln P_u^* + \alpha_s \ln P_s^* + \alpha_m \ln P_m^* + \frac{1}{2}\gamma_{uu}(\ln P_u^*)^2 + \frac{1}{2}\gamma_{ss}(\ln P_s^*)^2$$

$$+ \frac{1}{2}\gamma_{mm}(\ln P_m^*)^2 + \gamma_{us}(\ln P_u^*)(\ln P_s^*) + \gamma_{um}(\ln P_u^*)(\ln P_m^*) + \gamma_{sm}(\ln P_s^*)(\ln P_m^*)$$

$$+ \beta_k \ln K + \delta_{uk}(\ln P_u^*)(\ln K) + \delta_{sk}(\ln P_s^*)(\ln K) + \delta_{mk}(\ln P_m^*)(\ln K) + \frac{1}{2}\delta_{kk}(\ln K)^2 \quad (3.3.16)$$

where $\pi^* = \frac{\pi}{P_y}$, $P_u^* = \frac{P_u}{P_y}$, $P_s^* = \frac{P_s}{P_y}$, $P_m^* = \frac{P_m}{P_y}$.

Note that symmetry is also imposed across the translog profit function, (3.3.16); that is $\gamma_{us} = \gamma_{su}$, $\gamma_{um} = \gamma_{mu}$ and $\gamma_{sm} = \gamma_{ms}$.

With this final form shares are:

$$S_u = \alpha_u + \gamma_{uu} \ln P_u^* + \gamma_{us} \ln P_s^* + \gamma_{um} \ln P_m^* + \delta_{uk} \ln K \tag{3.3.17}$$

$$S_s = \alpha_s + \gamma_{ss} \ln P_s^* + \gamma_{us} \ln P_u^* + \gamma_{sm} \ln P_m^* + \delta_{sk} \ln K \tag{3.3.18}$$

$$S_m = \alpha_m + \gamma_{mm} \ln P_m^* + \gamma_{um} \ln P_u^* + \gamma_{sm} \ln P_s^* + \delta_{mk} \ln K \tag{3.3.19}$$

So we dropped one of share equations, namely output share, and the system became nonsingular. Now the translog profit function can be estimated with three shares.

3.4 Elasticities

This section presents the derivation of various input demand and output supply elasticities which will provide evidence about the real money balances in production function. We have followed Sidhu and Baanante (1981) in the derivation of the formulas.

The elasticities of variable input demands and output supply with respect to all exogenous variables have been evaluated at the mean values of the explanatory variables. These elasticities are also functions of the estimated parameters.

In our model capital is assumed to be a quasi-fixed input. And therefore we make a distinction between short-run and long-run elasticities. When capital is fixed, all elasticities are short-run elasticities. In the long-run, when capital is a variable input, we show the derivation of these elasticities.

In the case in which the capital is fixed the elasticities contain the information about **short-run**. When capital is not fixed, we obtain the **long-run** elasticities. We will find first short run elasticities and then long run elasticities in the proceeding section.

Short Run Elasticities:

Input Demand Elasticities:

Remember that

$$S_i = -\frac{P_i^* X_i}{\pi^*} = \frac{\partial \ln \pi^*}{\partial \ln P_i^*} \tag{3.4.1}$$

From above equation the demand equation for the *i*th variable input can be written as

$$X_i = \frac{\pi}{P_i}\left(-\frac{\partial \ln \pi}{\partial \ln P_i}\right) \tag{3.4.2}$$

$$\ln X_i = \ln \pi - \ln P_i + \ln\left(-\frac{\partial \ln \pi}{\partial \ln P_i}\right) \tag{3.4.3}$$

The short-run own-price elasticity of demand $\left(\eta_{ii}^{SR}\right)$ for X_i is

$$\eta_{ii}^{SR} = \frac{\partial \ln X_i}{\partial \ln P_i} = \frac{\partial \ln \pi}{\partial \ln P_i} - 1 + \frac{\partial \ln}{\partial \ln P_i}\left(-\frac{\partial \ln \pi}{\partial \ln P_i}\right) \tag{3.4.4}$$

So

$$\eta_{ii}^{SR} = -S_i^* - 1 - \frac{\gamma_{ii}}{S_i^*} \tag{3.4.5}$$

where S_i^* is the simple average of S_i.

Similarly from (3.4.3) the short-run cross price elasticity of demand $\left(\eta_{ih}^{SR}\right)$ for input *i* with respect to the price of the *h*th input can be obtained:

$$\eta_{ih}^{SR} = \frac{\partial \ln X_i}{\partial \ln P_h} = \frac{\partial \ln \pi}{\partial \ln P_h} + \frac{\partial \ln}{\partial \ln P_h}\left(-\frac{\partial \ln \pi}{\partial \ln P_i}\right) \tag{3.4.6}$$

$$\eta_{ih}^{SR} = -S_h^* - \frac{\gamma_{ih}}{S_i^*} \tag{3.4.7}$$

The short-run elasticity of demand for input i $\left(\eta_{iy}^{SR}\right)$ with respect to output price, P_y, can be also obtained from (3.4.3):

$$\eta_{iy}^{SR} = \frac{\partial \ln X_i}{\partial \ln P_y} = \frac{\partial \ln \pi}{\partial \ln P_y} - \frac{\partial \ln P_i}{\partial \ln P_y} + \frac{\partial \ln}{\partial \ln P_y}\left(-\frac{\partial \ln \pi}{\partial \ln P_i}\right) \qquad (3.4.8)$$

$$\eta_{iy}^{SR} = \sum_{i=1}^{n} \frac{\partial \ln \pi}{\partial \ln P_i}\frac{\partial \ln P_i}{\partial \ln P_y} - (-1) - \sum_{h=1}^{n}\frac{\gamma_{ih}}{S_i^*}(-1) \qquad (3.4.9)$$

where i=1..n, h=1..n

$$\eta_{iy}^{SR} = \sum_{i=1}^{n} S_i^* + 1 + \sum_{h=1}^{n}\frac{\gamma_{ih}}{S_i^*} \qquad (3.4.10)$$

Output Supply Elasticities:

Output supply elasticities with respect to output price, prices of variable inputs of production, and quantities of fixed factors, evaluated at averages of the S_i and at given levels of exogenous variables, can also be expressed as a function of parameters of the restricted profit function. From the duality theory (Lau and Yotopoulos, 1972) the equation for output supply can be written as

$$V = \pi + \sum_{i=1}^{n} P_i X_i \qquad (3.4.11)$$

The various supply elasticity estimates can be derived from this equation. Rewrite (3.4.11) with the help of (3.4.2) as follows:

$$V = \pi + \sum_{i=1}^{n} \pi\left(-\frac{\partial \ln \pi}{\partial \ln P_i}\right) \text{ or } V = \pi\left(1 - \sum_{i=1}^{n}\frac{\partial \ln \pi}{\partial \ln P_i}\right) \qquad (3.4.12)$$

$$\ln V = \ln \pi + \ln\left(1 - \sum_{i=1}^{n}\frac{\partial \ln \pi}{\partial \ln P_i}\right) \qquad (3.4.13)$$

Then, the short-run elasticity of supply $\left(\varepsilon_{vi}^{SR}\right)$ with respect to the price of the ith variable input is given by

$$\varepsilon_{vi}^{SR} = \frac{\partial \ln V}{\partial \ln P_i} = \frac{\partial \ln \pi}{\partial \ln P_i} + \frac{\partial \ln}{\partial \ln P_i}\left(1 - \sum_{h=1}^{n} \frac{\partial \ln \pi}{\partial \ln P_h}\right) \qquad (3.4.14)$$

where $i = h = 1..n$

And for the translog profit function case this becomes

$$\varepsilon_{vi}^{SR} = -S_i^* - \sum_{h=1}^{n} \gamma_{hi} \Big/ \left(1 + \sum_{h=1}^{n} S_h^*\right) \qquad (3.4.15)$$

The short-run own price elasticity of supply $\left(\varepsilon_{vv}^{SR}\right)$ is given by

$$\varepsilon_{vv}^{SR} = \frac{\partial \ln V}{\partial \ln P_y} = \frac{\partial \ln \pi}{\partial \ln P_y} + \frac{\partial \ln}{\partial \ln P_y}\left(1 - \sum_{i=1}^{n} \frac{\partial \ln \pi}{\partial \ln P_i}\right) \qquad (3.4.16)$$

$$\varepsilon_{vv}^{SR} = S_y + \frac{\partial \ln}{\partial \ln P_y}\left(1 - \sum_{i=1}^{n} \frac{\partial \ln \pi}{\partial \ln P_i}\right) \qquad (3.4.17)$$

$$\varepsilon_{vv}^{SR} = 1 - \sum_{i=1}^{n} S_i^* + \sum_{i=1}^{n}\sum_{h=1}^{n} \gamma_{ih} \Big/ \left(1 - \sum_{h=1}^{n} S_h^*\right) \qquad (3.4.18)$$

Long Run Elasticities:

In order to compute these elasticities we need the equilibrium condition for capital demand in the long-run. In the paper Lau and Yotopoulos (1972 p.13), it is reported that

$$\frac{\partial \pi}{\partial K} = \frac{\partial F}{\partial K} = \frac{P_k}{P_y} = P_k^* \qquad (3.4.19)$$

where F(.) is the production function and P_k^* is the normalized cost of capital.

So using this condition we can derive the derivatives of lnK as follows:

$$\frac{\partial \ln \pi}{\partial \ln K} = \frac{K}{\pi}\frac{\partial \pi}{\partial K} = \frac{K}{\pi}\left(-P_k^*\right) = S_k \tag{3.4.20}$$

and differentiating (3.3.16)

$$S_k = \beta_k + \delta_{uk} \ln P_u^* + \delta_{sk} \ln P_s^* + \delta_{mk} \ln P_m^* + \delta_{kk} \ln K \tag{3.4.21}$$

from (3.4.20) we can derive

$$\ln K - \ln \pi + \ln\left(-P_k^*\right) = \ln S_k \tag{3.4.22}$$

The equation (3.4.22) will guide us to derive long run elasticity formulas. Let's first derive input demand elasticities.

Input Demand Elasticities:

The elasticity of demand (η_{ik}) for input i with respect to the fixed factor K can be obtained from (3.4.3):

$$\eta_{ik} = \frac{\partial \ln X_i}{\partial \ln K} = \frac{\partial \ln \pi}{\partial \ln K} - \frac{\partial \ln P_i}{\partial \ln K} + \frac{\partial \ln}{\partial \ln K}\left(-\frac{\partial \ln \pi}{\partial \ln P_i}\right) \tag{3.4.23}$$

$$\eta_{ik} = \sum_{i=1}^{n} \delta_{ik} \ln P_i + \beta_k - \frac{\delta_{ik}}{S_i^*} \tag{3.4.24}$$

The own-price long run elasticity of demand (η_{ii}^{LR}) for X_i is

$$\eta_{ii}^{LR} = \left.\frac{\partial \ln X_i}{\partial \ln P_i}\right|_{K=\bar{K}} + \frac{\partial \ln X_i}{\partial \ln K}\frac{\partial \ln K}{\partial \ln P_i} \tag{3.4.25}$$

If we differentiate (3.4.22) with respect to $\ln P_i$

$$\frac{\partial \ln K}{\partial \ln P_i} - \frac{\partial \ln \pi}{\partial \ln P_i} - \frac{\partial \ln \pi}{\partial \ln K}\frac{\partial \ln K}{\partial \ln P_i} = \frac{\partial \ln S_k}{\partial \ln P_i} \tag{3.4.26}$$

$$\frac{\partial \ln K}{\partial \ln P_i} = \left(\frac{1}{1-S_k}\right)\left(S_i + \frac{\delta_{ik}}{S_k}\right) \tag{3.4.27}$$

Inserting (3.4.27) into (3.4.25), the long-run own-price elasticity of demand for X_i becomes

$$\eta_{ii}^{LR} = \eta_{ii}^{SR} + \eta_{ik}\left(\frac{1}{1-S_k}\right)\left(S_i + \frac{\delta_{ik}}{S_k}\right) \tag{3.4.28}$$

where η_{ii}^{SR} is the short run own price elasticity of demand for X_i and η_{ik} can be obtained by the equation (3.4.24).

The long-run cross price elasticity of demand $\left(\eta_{ih}^{LR}\right)$ for input i with respect to the price of the hth input can be obtained as:

$$\eta_{ih}^{LR} = \left.\frac{\partial \ln X_i}{\partial \ln P_h}\right|_{K=\bar{K}} + \frac{\partial \ln X_i}{\partial \ln K}\frac{\partial \ln K}{\partial \ln P_h} \tag{3.4.29}$$

Using (3.4.27) this becomes

$$\eta_{ih}^{LR} = \eta_{ih}^{SR} + \eta_{ik}\left(\frac{1}{1-S_k}\right)\left(S_h + \frac{\delta_{hk}}{S_k}\right) \tag{3.4.30}$$

The long-run elasticity of demand for input i $\left(\eta_{iy}^{LR}\right)$ with respect to output price, P_y, can be obtained as

$$\eta_{iy}^{LR} = \left.\frac{\partial \ln X_i}{\partial \ln P_y}\right|_{K=\bar{K}} + \frac{\partial \ln X_i}{\partial \ln K}\frac{\partial \ln K}{\partial \ln P_y} \tag{3.4.31}$$

The term $\partial \ln K / \partial \ln P_y$ can be derived from (3.4.22) as follows

$$\frac{\partial \ln K}{\partial \ln P_y} - \frac{\partial \ln \pi}{\partial \ln P_y} - \frac{\partial \ln \pi}{\partial \ln K}\frac{\partial \ln K}{\partial \ln P_y} - 1 = \frac{\partial \ln S_k}{\partial \ln P_y} \tag{3.4.32}$$

$$\frac{\partial \ln K}{\partial \ln P_y} = \left(\frac{1}{1-S_k}\right)\left(1 + S_y - \frac{\sum_i \delta_{ik}}{S_k}\right) \tag{3.4.33}$$

Using (3.4.33) the long-run elasticity of demand for input i with respect to output price is

$$\eta_{iy}^{LR} = \eta_{iy}^{SR} + \eta_{ik}\left(\frac{1}{1-S_k}\right)\left(1 + S_y - \frac{\sum_i \delta_{ik}}{S_k}\right) \tag{3.4.34}$$

Output Supply Elasticities:

The elasticity of output supply (ε_{yk}) with respect to the fixed input K is given by

$$\varepsilon_{yk} = \frac{\partial \ln V}{\partial \ln K} = \frac{\partial \ln \pi}{\partial \ln K} + \frac{\partial \ln}{\partial \ln K}\left(1 - \sum_{i=1}^{n} \frac{\partial \ln \pi}{\partial \ln P_i}\right) \tag{3.4.35}$$

$$\varepsilon_{yk} = \sum_{i=1}^{n} \delta_{ik} \ln P_i + \beta_k - \sum_{i=1}^{n} \delta_{ik} \Big/ \left(1 + \sum_{h=1}^{n} S_h^*\right) \tag{3.4.36}$$

The long-run elasticity of supply (ε_{yi}^{LR}) with respect to the price of the ith variable input is given by

$$\varepsilon_{yi}^{LR} = \left.\frac{\partial \ln V}{\partial \ln P_i}\right|_{K=K} + \frac{\partial \ln V}{\partial \ln K}\frac{\partial \ln K}{\partial \ln P_i}$$

(3.4.37)

Using (3.4.27), above equation becomes

$$\varepsilon_{yi}^{LR} = \varepsilon_{yi}^{SR} + \varepsilon_{yk}\left(\frac{1}{1-S_k}\right)\left(S_i + \frac{\delta_{ik}}{S_k}\right) \tag{3.4.38}$$

The long-run own price elasticity of supply (ε_{yy}^{LR}) is given by

$$\varepsilon_{yy}^{LR} = \left.\frac{\partial \ln V}{\partial \ln P_y}\right|_{K=\bar{K}} + \frac{\partial \ln V}{\partial \ln K}\frac{\partial \ln K}{\partial \ln P_y}$$

(3.4.39)

By the help of the equation (3.4.33), (ε_{yy}^{LR}) becomes

$$\varepsilon_{vv}^{LR} = \varepsilon_{vv}^{SR} + \varepsilon_{vk}\left(\frac{1}{1-S_k}\right)\left(1 + S_y - \frac{\sum_i \delta_{ik}}{S_k}\right) \tag{3.4.40}$$

The long-run own-price elasticity (ε_{kk}) of the fixed factor K can be derived as

$$\varepsilon_{kk} = \frac{\partial \ln K}{\partial \ln P_k^*} \tag{3.4.41}$$

Using equation (3.4.22)

$$\frac{\partial \ln K}{\partial \ln P_k^*} - \frac{\partial \ln \pi}{\partial \ln P_k^*} - \frac{\partial \ln \pi}{\partial \ln K}\frac{\partial \ln K}{\partial \ln P_k^*} + 1 = \frac{\partial \ln S_k}{\partial \ln P_k^*} \tag{3.4.42}$$

Some terms disappears and after arranging the terms

$$\varepsilon_{kk} = -\frac{1}{1-S_k} \tag{3.4.43}$$

The long-run elasticity of a fixed factor (ε_{ki}) with respect to ith variable input has already been obtained by equation (3.4.27):

$$\varepsilon_{ki} = \frac{\partial \ln K}{\partial \ln P_i} = \left(\frac{1}{1-S_k}\right)\left(S_i + \frac{\delta_{ik}}{S_k}\right) \tag{3.4.44}$$

The long-run elasticity of a fixed factor (ε_{ky}) with respect to output price has already been obtained at (3.4.33):

$$\varepsilon_{ky} = \frac{\partial \ln K}{\partial \ln P_y} = \left(\frac{1}{1-S_k}\right)\left(1 + S_y - \frac{\sum_i \delta_{ik}}{S_k}\right) \tag{3.4.45}$$

CHAPTER 4

DATA AND ESTIMATION PROCEDURE

4.1 The Data

The parameters of the translog profit function is estimated for three factors, namely, skilled labor, unskilled labor and real money balances with capital as a quasi-fixed factor using annual data on disaggregated 2 digit Canadian manufacturing industries which are clothing, food, furniture, and wood industries.

The data on real output, Q, was derived by deflating current dollar gross domestic product of the total manufacturing sector by its price index. Under a perfectly competitive equilibrium (zero profit condition), the output price only covers the unit cost of production which would amount to C=Q. This implies that the gross value of Q must include all costs and so we have zero profit. But since we are not making a perfectly competitive market assumption, the equality C=Q, is, therefore, not a binding constraint for the analysis. (Mahmud, 1993)

Two different kinds of labor inputs were considered, i.e., production and related workers (X_u) and administrative, office and other non-manufacturing employees (X_s) and they are measured as the total man-hours worked by the employee. Since Statistic Canada (STC) reports only the number of bodies for non-production workers, following Smith and Dennis (1978), the total number of bodies were multiplied by 37.5×52 to obtain annual hours worked by the non-production employees. The wage rates (P_u and P_s) have been derived by dividing total wages and salaries paid to each type of worker by their respective total man-hours.

The data for the real money balances (X_m) has been obtained from the year-end balance sheet of the total manufacturing sector. Cash has been taken as the measure of nominal money balances. The data for real money balances subsequently derived by dividing nominal money by industry selling price index of the total manufacturing sector. The price of holding one nominal dollar is measured by the interest rate (r). In the model, we assume that the services derived from the nominal money to the firms are directly proportional to the levels of real stocks of money. The price of holding one real dollar (P_m) is the interest rate multiplied by the price level. Thus, an increase in the price level will increase the price level of money services. The data on real capital stock is measured as the mid-year real net capital stock.

4.2 Estimation Procedure

The parameters of the translog profit function can be estimated in one of three ways. First, an ordinary least squares method can be used to estimate the profit function only. However, it neglects the additional information contained in the profit share equations. Secondly, we can estimate the set of share equations in a simultaneous equation framework, excluding the profit equation. Finally, we can estimate the profit function together with the share equations and this approach will be used through the this study.

A stochastic structure must be assumed for the equation system (profit and share equations) in order to estimate the parameters of the profit function. We assume that any deviations of the observed output supply and input demand quantities from their profit-maximizing levels are caused by random errors in optimization, and that these disturbances are additive with zero means and positive semidefinite variance-covariance matrix. This stochastic version of the profit function and share equations is estimated using the seemingly unrelated regression technique of **Zellner**. To attain maximum likelihood estimates which are invariant with respect to which equation is dropped, Barten (1969) showed that Zellner method estimates must be iterated until convergence. Parameter estimates achieved after only one iteration are not asymptotically efficient estimates.

CHAPTER 5

ESTIMATION RESULTS

The translog profit function and three share equations were estimated for disaggregated 2 digit manufacturing industries, which are clothing, food, furniture, and wood industries, using Zellner's seemingly unrelated algorithm in the TSP computer programme. In addition to the inputs mentioned before we also added time trend to the model to impose the technological progress and this also improves the Durbin-Watson (DW) statistics. We display the DW-statistics. And these DW-statistics are fairly high to warrant any further modification in model.

We also tested for the Cobb-Douglas hypothesis. It should be noted that, for the profit function to be Cobb-Douglas, coefficients of all second-order terms in (3.3.16) should be zero. It turned out that Cobb-Douglas hypothesis is rejected due to results in all four industries. The translog representation appears to be more suitable than the Cobb-Douglas for the data and model specification being analyzed.

In this chapter these four industries will be examined one-by-one and the results will be displayed.

5.1 Clothing Industry

We estimated translog profit function and shares for clothing industry data over the period 1965-1985. In the TSP computer programme convergence achieved after five iterations. The estimated parameters of translog profit function can be seen in table include time.

Table 5.1.1

Parameters	Estimates	T-Values
α_0	9.8361	0.5980
α_u	-2.3668	-7.0370
α_s	-0.6614	-7.3106
α_m	-0.0059	-1.0797
γ_{uu}	-0.4224	-5.9014
γ_{ss}	0.0367	2.6822
γ_{mm}	-0.0006	-2.9824
γ_{us}	-0.1085	-4.8680
γ_{um}	-0.0031	-1.8424
γ_{sm}	0.0013	1.1382
β_k	-1.9295	-0.2918
δ_{uk}	0.5093	6.5066
δ_{sk}	0.1214	6.1563
δ_{mk}	0.0007	0.6342
δ_{kk}	0.5664	0.4267
θ_t	0.0035	1.2688
θ_{ut}	-0.0050	-2.4881
θ_{st}	-0.0010	-1.7503
θ_{mt}	0.0000	-0.5191

Log of Likelihood: 344.978
DW Statistics for Profit Function: 1.57
DW Statistics for S_u: 1.40
DW Statistics for S_u: 1.35
DW Statistics for S_u: 2.40

The critical t-value for the estimates at ninety percent level of confidence for six degrees of freedom is 1.943. Then the parameters α_u, α_s, γ_{uu}, γ_{ss}, γ_{mm}, γ_{us}, δ_{uk}, δ_{sk},and θ_{ut} are significantly different from zero. This result is also true for ninety-five confidence level.

The long-run and short-run elasticities are given in table (5.1) at the end of the chapter. We are interested in the elasticities which are respect to price of money. So with those elasticities, we can decide the existence of real money balances in production function as a factor. Through this chapter we will discuss only significant elasticities.

As this table exhibits all own-price demand elasticities (η_{uu}), (η_{ss}), (η_{mm}) (both short and long run) for inputs are negative. The own-price elasticity (ε_{kk}) of capital is negative. And the own-price elasticity of supply (ε_{yy}) (both short and long run) is positive. This findings approve that our assumptions related to profit function model aren't satisfied, namely convexity is not violated.

The long-run cross-price elasticity of demand (η_{um}) for unskilled-labor with respect to price of money is -0.0077. **This finding is rather important, because it reflects the effect of money on a real variable in the long-run**. It indicates that nonproduction-workers are complementary to money in the long-run in the clothing industry. And the long-run cross-price elasticity of demand (η_{sm}) for skilled-labor with respect to price of money is 0.016. This means that nonproduction-workers are subtitutes to money in the long-run in the clothing industry So all these findings provide evidence for our claim that real money balances enters the production function as a factor. **This elasticities reject the neutrality of money, they all indicate that real money balances has impact on real variables.**

5.2 Food and Beverage Industry

Using data on food and beverage industries over the period 1965-1985, we estimated the translog profit function and shares together. In the TSP computer programme convergence achieved after seventeen iterations. Table (5.2.1) exhibits the estimated parameters of translog profit function.

Table 5.2.1

Parameters	Estimates	T-Values
α_0	0.6413	0.0787
α_u	-0.2862	-3.5985
α_s	-0.9013	-16.1970
α_m	-0.0280	-8.1861
γ_{uu}	-0.0571	-5.2597
γ_{ss}	-0.0891	-8.3008
γ_{mm}	-0.0011	-8.2084
γ_{us}	-0.0190	-3.2585
γ_{um}	0.0006	1.8881
γ_{sm}	-0.0028	-3.9630
β_k	1.3430	0.6842
δ_{uk}	0.0268	2.5536
δ_{sk}	0.1120	15.3970
δ_{mk}	0.0033	7.2361
δ_{kk}	-0.0870	-0.3679
θ_t	0.0015	0.0860
θ_{ut}	-0.0035	-2.1181
θ_{st}	-0.0047	-5.1089
θ_{mt}	-0.0001	-3.7832

Log of Likelihood: 382.973
DW Statistics for Profit Function: 1.62
DW Statistics for S_u*:* 1.66
DW Statistics for S_u*:* 1.31
DW Statistics for S_u*:* 1.83

The critical t-value for the estimates at ninety percent level of confidence for six degrees of freedom is 1.943. So all estimated parameters, other than α_0, β_k, γ_{um}, δ_{kk}, θ_t are significantly different from zero. This result is same even for ninety-five confidence level.

Table (5.2) exhibits the various short and long run elasticities at the end of chapter. As can be seen from this table, all own-price demand elasticities (η_{uu}), (η_{ss}), (η_{mm}) (both short and long run) for inputs are negative. The own-price elasticity (ε_{kk}) of capital is negative. And the own-price elasticity of supply (ε_{yy}) (both short and long run) is positive.

The short-run cross-price elasticity of demand (η_{um}) for unskilled-labor with respect to price of money is 0.006, for long run this elasticity is 0.029. And the short-run cross-price elasticity of demand (η_{sm}) for skilled-labor with respect to price of money is –0.026. The elasticity of capital with respect to price of money is (ε_{km}) 0.014. According to these results, in food and beverage industry production-workers and capital are substitutes to money. And nonproduction-workers are complementary to money. These results are exactly the opposite of clothing industry results. In clothing industry when interest rate increases the demand for skilled-labor increases. This may arise from the need of skilled-labor for clothing industry rather than food industry.

5.3 Furniture and Fixtures Industry

We estimated translog profit function and shares for furniture and fixtures industry data over the period 1965-1984. In the TSP computer programme convergence achieved after nine iterations. The estimated parameters of translog profit function can be seen in table (5.3.1).

Table 5.3.1

Parameters	Estimates	T-Values
α_0	-5.1743	-0.5287
α_u	-0.3003	-2.1595
α_s	-0.2217	-3.3326
α_m	-0.0111	-2.4945
γ_{uu}	-0.0810	-1.2787
γ_{ss}	-0.0882	-2.0420
γ_{mm}	-0.0015	-5.2044
γ_{us}	0.0335	0.9516
γ_{um}	-0.0032	-1.4136
γ_{sm}	-0.0003	-0.1005
β_k	3.8542	1.0350

δ_{uk}	0.0076	0.2325
δ_{sk}	0.0424	2.8334
δ_{mk}	0.0017	1.7093
δ_{kk}	-0.5969	-0.8445
θ_t	-0.0054	-0.9405
θ_{ut}	-0.0017	-1.2645
θ_{st}	-0.0007	-1.2238
θ_{mt}	-0.0001	-4.2437

Log of Likelihood: 302.558
DW Statistics for Profit Function: 1.87
DW Statistics for S_u: 1.61
DW Statistics for S_u: 1.43
DW Statistics for S_u: 1.65

The critical t-value for the estimates at ninety percent level of confidence for five degrees of freedom is 2.015. Then the parameters α_u, α_s, α_m, γ_{mm}, γ_{ss}, δ_{sk}, θ_{mt} are significantly different from zero.

The long-run and short-run elasticities are given in table (5.3) at the end of the chapter. Again in furniture and fixture industry all own-price demand elasticities (η_{uu}), (η_{ss}), (η_{mm}) (both short and long run) for inputs are negative. The own-price elasticity (ε_{kk}) of capital is negative. And the own-price elasticity of supply (ε_{vv}) (both short and long run) is positive.

For furniture and fixtures industry the short-run elasticity of supply with respect to price of money (ε_{vm}) is significant, -0.009. This shows that in short-run real money balances affects the output. Only one of the elasticities in interest is significant, the reason is only a few parameters are significant in regression fot this industry.

5.4 Wood Industry

We estimated translog profit function and shares for wood industry data over the period 1965-1985. In the TSP computer programme convergence achieved after five iterations. The estimated parameters of translog profit function can be seen in table (5.4.1).

Table 5.4.1

Parameters	Estimates	T-Values
α_0	16.5420	7.5584
α_u	-0.7023	-5.0602
α_s	0.0307	0.5318
α_m	-0.0129	-4.2822
γ_{uu}	-0.2718	-11.1910
γ_{ss}	-0.1120	-6.6065
γ_{mm}	-0.0014	-9.1730
γ_{us}	0.0375	2.1001
γ_{um}	-0.0011	-0.8483
γ_{sm}	0.0005	0.3690
β_k	-3.0498	-5.1169
δ_{uk}	0.0847	4.3619
δ_{sk}	0.0021	0.2893
δ_{mk}	0.0011	3.0695
δ_{kk}	0.5027	6.1692
θ_t	0.0219	3.2477
θ_{ut}	0.0153	4.9088
θ_{st}	0.0047	4.3858
θ_{mt}	0.0002	4.0451

Log of Likelihood: 347.197
DW Statistics for Profit Function: 1.60
DW Statistics for S_u*:* 1.89
DW Statistics for S_u*:* 1.56
DW Statistics for S_u*:* 1.81

The critical t-value for the estimates at ninety percent level of confidence for six degrees of freedom is 1.943. Then all parameters, other than α_s, γ_{um}, γ_{sm}, δ_{sk} are significantly different from zero.

The long-run and short-run elasticities are given in table (5.4) at the end of the chapter. As can be seen from this table, all own-price demand elasticities (η_{uu}), (η_{ss}), (η_{mm})

(both short and long run) for inputs are negative (excluding insignificant ones). The own-price elasticity (ε_{kk}) of capital is negative. And the own-price elasticity of supply (ε_{yy}) (both short and long run) is positive.

The long-run cross-price elasticity of demand (η_{sm}) for skilled-labor with respect to price of money is 0.009. So in wood industry nonproduction-workers are substitutes to money in the long-run as in food industry, so food and wood industries have similiar features.

Table 5.1

CLOTHING INDUSTRY ELASTICITIES				
	SHORT-RUN		**LONG-RUN**	
	ESTIMATE	T-STAT	ESTIMATE	T-STAT
η_{uu}	-2.0075	-8.8960	-2.0206	-79.8000
η_{ss}	-0.4982	-3.2339	-0.4979	-873.6000
η_{mm}	-1.4046	-10.2840	-1.4064	-1050.0000
η_{um}	-0.0083	-1.5643	**-0.0077**	**-19.5430**
η_{mu}	-1.7990	-1.5633	-1.7545	-20.4800
η_{sm}	0.0162	1.2510	**0.0162**	**464.5400**
η_{ms}	0.9847	1.2506	0.9720	44.5200
η_{su}	-0.9010	-3.5886	-0.9021	-403.3600
η_{us}	-0.2516	-3.5881	-0.2479	-38.4120
ε_{vm}	0.0055	3.4538	0.0005	0.1434
ε_{vu}	1.2220	9.0463	1.3456	5.6492
ε_{vs}	0.2082	6.8062	0.1728	2.8467
ε_{vv}	0.9783	14.6250	10.8710	6.3825
η_{uk}	-	-	0.2563	0.0389
η_{sk}	-	-	0.0226	0.0034
η_{mk}	-	-	-0.8671	-0.1329
ε_{vk}	-	-	-2.4108	-0.3641
ε_{kk}	-	-	-2.0689	-5.9906
ε_{ku}	-	-	-0.0513	-0.5189
ε_{ks}	-	-	0.0147	0.5827
ε_{km}	-	-	0.0021	1.3318
ε_{kv}	-	-	-4.1033	-5.8081

Table 5.2

FOOD AND BEVERAGE INDUSTRY ELASTICITIES				
	SHORT-RUN		**LONG-RUN**	
	ESTIMATE	T-STAT	ESTIMATE	T-STAT
η_{uu}	-1.2316	-16.9530	-2.1734	-10.2920
η_{ss}	-1.7534	-16.9150	-1.2870	-11.1600
η_{mm}	-1.8711	-17.1300	-1.8155	-115.1800
η_{um}	**0.0055**	**2.4535**	**0.0286**	**4.3729**
η_{mu}	0.6491	2.4510	-1.6171	-3.1824
η_{sm}	**-0.0256**	**-3.7724**	0.0098	0.9732
η_{ms}	-2.0924	-3.7518	-1.3590	-7.4944
η_{su}	-0.0328	-0.5859	-1.4740	-4.5615
η_{us}	-0.0228	-0.5859	0.2820	3.7423
ε_{vm}	0.0057	6.6292	0.0237	4.6367
ε_{vu}	0.2512	14.8440	-0.4852	-2.9387
ε_{vs}	0.2528	21.9240	0.4911	8.3354
ε_{vv}	1.1039	87.7300	14.2850	4.5103
η_{uk}	-	-	1.6940	0.8628
η_{sk}	-	-	2.5923	1.3147
η_{mk}	-	-	4.0762	1.9742
ε_{vk}	-	-	1.3245	0.6748
ε_{kk}	-	-	-4.7946	-4.1439
ε_{ku}	-	-	-0.5560	-4.4599
ε_{ks}	-	-	0.1799	4.0447
ε_{km}	-	-	0.0137	3.5305
ε_{kv}	-	-	9.9515	4.1618

Table 5.3

FURNITURE AND FIXTURES INDUSTRY ELASTICITIES				
	SHORT-RUN		**LONG-RUN**	
	ESTIMATE	T-STAT	ESTIMATE	T-STAT
η_{uu}	-1.0157	-4.4371	-4.9805	-2.8703
η_{ss}	-1.8794	-3.9520	-2.4279	-7.0975
η_{mm}	-2.0680	-9.5272	-2.0493	-74.9890
η_{um}	-0.0102	-1.2425	0.0041	0.1978
η_{mu}	-2.0156	-1.2377	-7.1998	-3.1733
η_{sm}	-0.0016	-0.0542	0.0142	0.6135
η_{ms}	-0.1064	-0.0542	-0.7518	-1.8677
η_{su}	0.6460	1.6654	-3.7600	-1.9499
η_{us}	0.2120	1.6655	-0.2816	-0.9148
ε_{vm}	0.0093	2.7918	0.0232	1.1399
ε_{vu}	0.3573	3.5035	-3.4975	-2.0731
ε_{vs}	0.1779	3.6309	-0.3020	-1.0090
ε_{vv}	1.2884	22.0600	34.5300	2.1111
η_{uk}	-	-	3.9448	1.0668
η_{sk}	-	-	4.3838	1.1950
η_{mk}	-	-	5.1581	1.3987
ε_{vk}	-	-	3.8354	1.0286
ε_{kk}	-	-	-3.7703	-1.9872
ε_{ku}	-	-	-1.0051	-2.2849
ε_{ks}	-	-	-0.1251	-1.6035
ε_{km}	-	-	0.0036	0.6838
ε_{kv}	-	-	8.6671	2.0323

Table 5.4

WOOD INDUSTRY ELASTICITIES

	SHORT-RUN		**LONG-RUN**	
	ESTIMATE	T-STAT	ESTIMATE	T-STAT
η_{uu}	-1.4559	-19.8770	0.7281	1.6015
η_{ss}	-2.2764	-10.8820	-1.4373	-10.1550
η_{mm}	-1.8381	-18.4320	-1.8367	-492.6400
η_{um}	-0.0016	-0.4082	0.0000	-0.0004
η_{mu}	-0.3164	-0.4080	1.5395	3.9849
η_{sm}	0.0074	0.4804	**0.0092**	**1.9296**
η_{ms}	0.3554	0.4804	1.0142	9.1265
η_{su}	0.7957	3.6705	3.1593	6.4208
η_{us}	0.1924	3.6749	0.9677	7.3995
ε_{vm}	0.0054	7.8284	0.0072	1.4353
ε_{vu}	0.7505	22.6300	3.2590	6.2411
ε_{vs}	0.2113	24.5640	1.1018	7.3354
ε_{vv}	1.2065	84.3420	27.0170	4.3224
η_{uk}	-	-	-2.7019	-4.2797
η_{sk}	-	-	-2.9242	-4.4553
η_{mk}	-	-	-2.2959	-3.6144
ε_{vk}	-	-	-3.1033	-5.2411
ε_{kk}	-	-	-3.6106	-3.9875
ε_{ku}	-	-	-0.8083	-4.8038
ε_{ks}	-	-	-0.2870	-5.9286
ε_{km}	-	-	-0.0006	-0.3643
ε_{kv}	-	-	8.3171	4.1294

CHAPTER 6

CONCLUSION

The purpose of this thesis was to investigate whether or not real money balances are important productive inputs of Canadian manufacturing industries. To this end, a four input (X_u, X_s, X_m, K) translog profit function was employed for estimating production parameters, short-run and long-run elasticities using annual Canadian data over the period 1965-1987.

In this thesis we employ a translog profit function model to test if real money balances enter production function as an input and we show the derivation of short-run and long-run elasticities in the context of translog profit function as a contribution to the existing literature.

The most of the parameters in translog profit function turned out to be significant. Estimated elasticities were compatible with the theory and they were consistent with the assumptions of translog profit function. For instance, all own-price elasticities were negative, so this implies that convexity assumption has not violated.

One of the important findings of our study is that the real money balances are indeed important factors of production for the Canadian manufacturing sector. This does not mean that the real money balances are like any other factors of production but rather they indirectly help and facilitate the process of production. Generally our cross price elasticities estimates suggest that we have mixed results, such that the non-production workers and money appear to be complements to each other in some industries and substitutes to each other for some other industries. This is true also for production-workers. Another interesting result that emerges from our study is the significance of the potential supply side effect of a change in the interest rate on both labor demand and supply of output. So this leads to the conclusion that the changes in financial policies have effect on real variables.

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